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Bearing system cuts engine costs, saves fuel

by Michael Kelly, Propulsion Directorate

WRIGHT-PATTERSON AIR FORCE BASE, Ohio — Advances in bearing systems for gas turbine engines, powering target drones and cruise missiles could cut engine costs by as much as 20 percent and significantly increase fuel efficiency in these air vehicles with limited life applications.

Scientists and engineers in the Air Force Research Laboratory's Propulsion Directorate are testing a bearing using a compliant foil — a thin, flexible sheet of metal — rather than conventional rolling elements like balls or rollers.

An air foil bearing developed under an Air Force Small Business Innovation Research contract by Mohawk Innovative Technology Inc. is being tested in a WJ24-8 target drone engine at Williams International, in Walled Lake, Mich. Tests are expected to be completed in June.

The advanced bearings support an engine's rotor on a hydrodynamic air film eliminating the need for rolling element bearings and their associated liquid lubrication system, according to Matt Wagner, the project's manager and a mechanical engineer in the directorate's Turbine Engine Division.

"Conventional rolling element bearings produce frictional drag and require cooling, both of which decrease engine performance," he said. "Eliminating the current oil-mist lubrication system and roller bearing from the WJ24-8 could reduce engine weight by as much as 10 percent."

According to Wagner, bearing lubrication systems in aerial targets — or drones — and cruise missiles typically account for 10 to 30 percent of the engine cost and weight, as well as a substantial portion of required maintenance.

In contrast, air foil bearings require no lubrication system; require little cooling and produce substantially less friction than their predecessor, Wagner said. Air foil bearings will also operate at much higher speeds and temperatures which facilitates next generation engines with greater capabilities and efficiencies built in.

Foil air bearings have been around since the 1970s and used primarily in aircraft air cycle machines that circulate air through the cabin for environmental control. Wagner noted they have historically been limited in size, load capacity and high temperature operation — until now.

Recent research programs conducted by the Propulsion Directorate and NASA have addressed each of these areas, he said, and the bearing has been successfully developed for future testing in the Joint Expendable Turbine Engine Concept engine demonstrator, known as the XTL-87.

Wagner said the WJ24-8 tests demonstrated stable operation of the air foil bearing throughout a series of cyclic and mission simulation testing. The data from these tests will be used to assess the applicability of foil bearings to other gas turbine engines for both military and commercial systems. @